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THE EFFECT OF STRONG GALES ON FOLIAGE

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Attention was first called to the fact that leaves may be badly damaged by very high winds in a letter to the *Meteorological Magazine* in January, 1937(1)*. After a severe gale from the NNW at Llannerch Park, Trefnant, on October 19th, 1936, a large number of different kinds of trees and shrubs were found to have been damaged, the leaves having turned quite a different colour from the usual tints associated with autumn. The same occurrence was reported by the writer's father, in the *Gardeners' Chronicle*(2). Since then much discussion on the nature of the damage has arisen, and much been written on the subject.

Since October, 1936, nearly thirty reports of the blasting of foliage by strong winds have been collected. In the first case put on record, young sycamores suffered the most and elms, thorn hedges and hardy fuchsias were also affected. Since then, various observers have reported similar damage to nearly all the common deciduous trees, smaller things such as blackberries, together with a large number of the rarer shrubs and plants found in parks and gardens and, after another severe gale at Trefnant on October 3rd to 4th, 1938, it was necessary to put on the list even thistles, lettuce and artichokes, the latter being quite ruined as a crop,

* The numbers in brackets refer to the references at the end of the article.

many of the plants, tall and healthy as they were, dying outright within a short time. Nettles, mangolds and cider apple trees have also been reported damaged by the same agency. An important conclusion from the reports is that they nearly all state that the damage becomes much less severe with increasing distance from the coast, that the damage is worst in the more exposed situations and, in the case of a tree, the damage is greater on the windward side than on the leeward side.

The problem is one which interests meteorologists, forestry experts and horticulturists. In considering theories to explain the phenomenon we will confine ourselves to factors operating in the British Isles, leaving out of consideration, for instance, the scorching caused by hot, dry winds in semi-desert areas. There are three main theories to explain the damage caused in the British Isles, viz:—

- (a) that it is owing to some effect in the leaf due simply to the high wind speed or pressure;
- (b) that, near the coast and in some other places, it is due to sand raised and carried by the wind;
- (c) that salt, raised as spray from the sea, and carried inland by the wind, is responsible.

Let us take the first theory and the various explanations offered as to how the damage is occasioned. M. C. Goldsworthy(3) has suggested that the effects observed are due to the friction caused between moving plant-parts due to the high wind. This theory can be disposed of, however, as mechanical buffeting would result in a battered and torn appearance in the leaves and not the blasted appearance described by observers. And this theory will not explain the discoloration of such things as lettuces and nettles. Another theory due to the same writer is that the responsible agency is the flooding of the intercellular spaces in the leaf by water driven against the surface, thereby upsetting the water-balance between roots and leaves, and killing the leaves. This theory will be mentioned later, but in this connection mention must be made of one occasion of slight damage by a gale during which there was not a

single drop of rain, so that it will not explain every case. L. C. W. Bonacina(4) has propounded a theory diametrically opposed to this, in which he suggests that loss of water due to evaporation causes shrivelling of the leaf. This may explain the isolated case mentioned above but is invalid in the other cases, as all of them have been reported as being accompanied by heavy precipitation. The leaves would thus be continually wet and evaporation, if any, would take place rather from the water on the leaf than from the sap inside the cells. Another theory is one recently put forward in a leading article in the *Gardeners' Chronicle*(5), which suggests that evaporation produces such low temperature in the leaf that it dies of cold. Unfortunately the theory overlooks the fact that several degrees of frost are necessary to kill leaves on a deciduous tree. Leaves in a condition liable to be damaged by a gale are only found on deciduous trees between mid-May and October and a storm of wind and rain occurring during this period is not likely to be accompanied by a wet-bulb temperature of below 38° F., which is not low enough to harm any leaves. The last theory under this heading is that due to T. Willcocks(6), who states that the mechanical strains and stresses in the leaves result in rupture of the cell-walls, thereby causing various complex chemical substances in the leaves to come into contact, react, and produce a brownish or blackish product, thus explaining the scorched appearance. These chemical reactions are stated in detail, and this may very well be the correct explanation, but no information was given as to whether chemical analysis was actually employed and, in the absence of this, one must naturally exercise care in estimating the validity of the hypothesis.

Under the second heading comes the suggestion by E. Long(7) that sand blown against the leaf-surface is responsible for the browning, as a parallel to what happens in dry hot climates during sandstorms and dust-storms. But in this country sand is not likely to be effective owing to the rain which accompanies the gales

which would cause the sand to be wet and hence difficult to be raised by the gale. Furthermore, in the one or two instances in which it was thought that sand might be responsible, further investigation showed that, at the part of the coast over which the wind had blown, the beach was composed of pebbles and not of sand at all.

We now come to the third heading, namely that of sea-salt brought in by the gale. It is well known that salt nuclei are always present to some extent in the air over Britain and further, that the quantity is increased considerably during very strong winds. A number of instances of the transport of large quantities of salt, some of them up to the remarkable distance of 100 miles or more from the coast, have been given by S. T. A. Mirrlees(8). The suggestion that such salt was responsible for the damage to foliage was first put forward by S. Ashmore(2) and the suggested mechanism of the action of the salt on the plants was put forward by the writer(1), i.e., that the strong solution of salt in contact with the leaf causes rapid loss of water from the cells through osmotic pressure, thus causing the collapse of the cells and their walls and the shrivelling of the leaf. This theory is directly opposed to that of Goldsworthy(3). Evidence has been received from W. M. Thomson(9) at Taranako, New Zealand, that south-easterly gales are apt to transport so much salt inland that serious damage is done to trees and shrubs, particularly acacias and hawthorn. On one occasion a gale completely destroyed a plantation of *Pinus radiata*, twelve trees thick and of average height 30 feet, by defoliation through the action of salt. It is quite reasonable to suppose that salt can be brought inland in Britain in the same manner to cause similar damage. Experimental evidence in support of the salt theory is available. Wells and Shunk(10) and Laflin and Phillips(11) have both tried the experiment of spraying leaves, shoots and plants with brine of varying strength up to that of sea-water and have obtained discoloration precisely similar to that observed after gales. Both accept that this is due to water loss by osmosis, thus

bearing out the writer's original theory. Why root-action does not accelerate and make up the water-loss is an obscure question; it was raised long ago by Lewis(12), and its answer must be left to the biologists.

In summarising, it is fairly clear that the effect under discussion is either due to sea-salt or simply to the high wind speed; to decide which is operative in the majority of cases we must take into consideration that the damage is nearly always described as becoming much less with increasing distance from the coast. One expects the salt-content of the air to decrease fairly rapidly on going inland because of its precipitation with the rain but the effect of high wind-speed alone is not likely to diminish nearly so much, and this factor, to the writer's mind, weighs in favour of the sea-salt theory. In practically all the reports, the wind, even if blowing off-shore at the place where damage occurred, had recently passed over the sea and had opportunity to raise large quantities of spray. Nevertheless, there may be at work another factor, due simply to the effect of the high wind speed, either working in conjunction with the salt effect, or, on occasions, effective by itself. Mention has already been made of the solitary record of damage caused by a strong wind unaccompanied by any precipitation; this was at Trefnant on October 4th, 1939. On this occasion the wind was SE, not exceptionally strong, but sufficient to blow down small elm branches. It was dry and cold, and the damage consisted of withering of the leaves of dahlias and the withering of the flowers of dahlias and various herbaceous plants; the damage was not extensive. Now, if salt was present on this occasion, it would have had an excellent chance of being effective owing to the absence of dilution by rain, but according to data very kindly supplied to the writer by the Director of the Meteorological Office, it appears that this wind originated over central Europe the only water included in its trajectory being the English Channel, so that it is hardly likely that there was any appreciable salt content in the wind, and that this observation must go to prove that in a minority of cases,

the damage is caused by some effect due to the wind strength alone.

In order to ascertain the relative frequencies in which the two effects (or possibly more) are operative, it will be desirable to conduct experiments on the following lines:—plants, small trees and shoots should be introduced into a wind-tunnel, where they can be subjected to the action of winds of the order experienced in gales, firstly with a dry air-stream, secondly with fine drops of water in the air-stream to represent rain and thirdly with fine drops of dilute brine, both constant and intermittent. The effect on the foliage could be readily observed and the discoloured leaves analysed by a chemist. This method would also settle the question why every gale occurring during the right season, and suspected of bearing salt, does not damage foliage. Capt. Cave(13) suggests that gales causing damage have periods when the precipitation ceases for a time, the wind remaining high. Evaporation from the leaf-surfaces would concentrate the salt-solution in contact with them, giving osmotic pressure a chance to work, and withdrawing water from the leaves. Until wind-tunnel experiments can be carried out it is hoped that observers with anemometers and hyetographs will, when they observe gale damage of this kind, refer to the charts to ascertain if, during the gale, there were periods of light or absent rainfall, accompanied still by high wind-speed, as Capt. Cave has suggested.

REFERENCES

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 - (2) S. Ashmore, *Gard. Chron.*, 100, 1936, 341.
 - (3) M. C. Goldsworthy, *Gard. Chron.*, 101, 1937, 75.
 - (4) L. C. W. Bonacina, *Met. Mag.*, 72, 1937, 12.
 - (5) Editor, *Gard. Chron.*, 104, 1938, 315.
 - (6) T. Willcocks, *Gard. Chron.*, 104, 1938, 162.
 - (7) E. Long, *Gard. Chron.*, 104, 1938, 219.
 - (8) S. T. A. Mirrlees, *Met. Mag.*, 63, 1928, 131.
 - (9) W. M. Thomson, *Gard. Chron.*, 105, 1939, 375.
 - (10) Wells and Shunk, *Bull. Torr. Bot. Club*, 65, No. 7, 1938, 485.
 - (11) Laffin and Phillips, *Gard. Chron.*, 105, 1939, 14.
 - (12) Lewis, *New Phytologist*, 11, 1912, 255.
 - (13) C. J. P. Cave, *Met. Mag.*, 73, 1938, 276.
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LETTERS TO THE EDITOR

Static Charge

Whilst ascending the iron ladder to the roof of the Experimental Station Central Offices at 18h. 10m. G.M.T., September 8th, 1939, I received an appreciable electric shock from the iron piping that serves as a railing at the top of the ladder. About ten minutes later—whilst following a pilot balloon—I received a further and more severe shock. Blue flashes were observed playing round the theodolite and theodolite base, and a burning sensation around the throat, coupled with a tingling sensation in both hands, was experienced. A few moments later I had occasion to change the sun-card, and experienced a still further shock when I touched the metal surrounding the glass sphere—though not of such intensity as the two previous shocks.

Subsequent examination of these metal parts by the Orderly Officer and an electrician elicited no further shocks and it was assumed that by making contact with the various charged places mentioned I had discharged the stored up electrical energy through my person.

E. T. YOUNG-EVANS.

*Shoeburyness, Essex.
September 8th, 1939.*

Mammatus Cloud and Mirage

On August 20th, 1939, some interesting mammatus cloud was seen near Foynes. Although first noted at 7h. G.M.T., no detailed observations were made until 9h. 15m., after which time it was watched by H. H. Lamb, A. K. Dewdney and the writer. The base of the cumulo-nimbus cloud in which the mammatus structure formed was then at about 3,000 ft.; later, when the cloud had degenerated, its base was at least 1,000 feet higher. Below the cloud winds converged from east and west and an anticyclonic whirl developed between the two air-streams. Cloud fragments moving

from the east below the main cloud at times formed almost complete horizontal circles. At other times similar fragments moved spirally upwards, dissolving as they ascended. North east of the whirl the cloud was continually reforming and dissolving, the lowest portions always being the last to disappear.

Downward currents existed over a wide area and a small cumulus cloud at least 10 miles away was observed to flatten rapidly and ultimately to disappear. By 9h. 50m. the cloud had thinned considerably and the mammatus form was less pronounced.

A little later, at 10h. 30m., a mirage was observed from Foynes Pier by H. H. Lamb and A. K. Dewdney. Two distinct images, one above the other, could be seen of Low Island, about 6 miles away across the Shannon and part of the water surface appeared to be tilted.

F. E. DIXON.

*Hotel Ardanoir, Foynes, Eire.
August 31st, 1939.*

The First Pressure Tube Anemometer

In your issue for June last you recorded the fact that the original Pressure Tube Anemometer which was used by Mr. W. H. Dines at Oxshott towards the end of last century had recently been presented to the Science Museum. This is believed to be the first instrument of the type ever constructed. While sorting some old papers at Benson I have recently obtained evidence of the date when this anemometer was first brought into use and it is perhaps worth putting the facts on record. Among the papers there were a number of early Pressure Tube records from Oxshott, the series commencing with a chart for November 9th-10th, 1893. This record and those for the following days were taken on blank paper on which horizontal lines had been ruled in pencil corresponding with 0, 10, 20, etc. miles per hour, the velocities being indicated by numbers entered in Mr. Dines' handwriting. There were no hour lines but the time of commencement and end of the record were entered. The series is not quite complete and there are

several breaks of a few days. After one of these the blank forms gave way on December 12th to a printed form substantially similar to those now used. There seems good reason to believe therefore that November, 9th, 1893, was the day on which the Pressure Tube Anemometer first came into regular use. It is of interest to note that the record for May 20th, 1894, bears the pencil legend "Common ink and drawing pen" showing that Mr. Dines early found it necessary to experiment with different types of pen. The earliest records appear to have been made with a mapping pen of the type which is still in general use.

J. S. DINES.

Benson.

September 12th, 1939.

NOTES AND NEWS

The Droughts and Dry Spells of August and September.

The rainfall over the British Isles was markedly deficient during the months of August and September, the general rainfall, expressed as a percentage of the average for the period 1881–1915, being 70 and 63 respectively for these months. The records for individual stations show that there was a dry period in each month which affected many parts of the country.

In this account, the definitions adopted in *British Rainfall* will be used, namely:—

An absolute drought is a period of at least 15 consecutive days, to none of which is credited $\cdot 01$ inch of rain or more.

A partial drought is a period of at least 29 consecutive days, the mean daily rainfall of which does not exceed $\cdot 01$ inch.

A dry spell is a period of at least 15 consecutive days to none of which is credited $\cdot 04$ inch of rain or more.

During August the largest region affected by prolonged dry weather was central Ireland together with the central portion of the west coast, the area being

enclosed by a line running north-east from Ballynahinch (Galway) to Edenfel (Tyrone), thence south to Blandsfort (Leix), south-west to Cork and west to BallyMcElligott (Kerry). Almost every station within this region experienced a dry spell and at nearly 50 per cent. the drought was absolute. The most general date for the commencement of the absolute drought or dry spell was the 10th or 11th, though occasionally the start was as late as the 15th. Within the same dates, absolute drought commenced in north-west Mayo and a dry spell in north Donegal. Anglesey and part of the north Welsh coast recorded absolute drought at this time. Over Hampshire (excluding the Isle of Wight), east Wilts. and west Sussex there was a dry spell commencing on the 11th, one-third of the stations recording absolute droughts. North-east Kent, north-east Essex and most of Suffolk experienced dry spells, the drought becoming absolute inland, but at the most easterly Suffolk stations the beginning of the dry spell was the 25th. Isolated reports of dry spells were received from Ullapool (Ross and Crom.), Lairg (Suth.), Aberdeen and Blockley (Glos.)

During the latter portion of September almost the whole of Ireland experienced an absolute drought or a dry spell, the most frequent dates of commencement being the 13th or 14th. North and west of a line running from BallyMcElligott (Kerry) to Foffanny (Down) the drought was absolute at nearly all stations, in spite of the fact that, for example, the Antrim stations received over 125 per cent. of their average rainfall during the month, largely as a result of heavy rain on the 3rd.

In England and Wales, absolute drought was less common, but a line from Ventnor (I. of W.) through Ragley (Warw.) to Blaenau Festiniog (Mer.) encloses to the south and west a region within which dry spells predominated, with a tendency to conditions of absolute drought at the coastal stations. At three stations within this region, the dry conditions began as early as the 3rd, and on the 5th at another. Over almost the whole area these conditions persisted until the end of the month.

A dry spell was also experienced in east Essex beginning on the 16th.

In the north-west of England and in Scotland dry spells or absolute droughts were the rule south and west of a line from Barra, Skallary (Inv.) to Montrose (Angus) and Southport (Lancs.) although a few stations were exceptional in this respect. The more westerly portions of this region usually experienced absolute droughts.

The thunderstorms at the beginning of September interrupted the dry conditions of August and September; consequently there are only three records of partial droughts, from Margate, Kent (Aug. 5th—Sept. 17th) Lexden Hill House, Essex, (Aug. 9th—Sept. 30th) and Haughley House, Suffolk (Aug. 11th—Sept. 30th).

W. H. HOGG.

Auroral Notes for August, 1939.

A report has been received from Mr. H. H. Lamb at Foynes of the aurora observed from Imperial Airways aircraft "Caribou" on the night of August 10th, 1939, as mentioned in the Press. The "Caribou" was home-ward bound and at 24h. G.M.T., when about 300 miles east of Newfoundland she reported strong aurora right across the northern sky and reaching an elevation of 40° . Aurora was observed at Foynes by Mr. F. E. Dixon and Mr. Lamb earlier on the same evening and also during the night of August 11th. On the latter occasion the sky was thinly overcast but the lighting through the cloud suggested aurora of curtain formation. Observations on this occasion were discontinued after 23h. 30m. but there was interference with wireless telegraphic communication between Foynes and Botwood, Newfoundland, from about that time until 13h. 50m. on the 12th. It is of interest to note that a "sudden commencement" was recorded in the magnetic elements at Eskdalemuir Observatory at 1h. 42m. on August 12th, magnetic disturbance persisting during the remainder of the day. A medium sized sunspot passed the sun's central meridian on August 11th. (*Nature* Vol. 144, p. 362.)

A short display of aurora was seen from St. Andrews on the evening of the 16th. The aurora which reached its maximum by 23h. and had died away an hour later was of arc formation with some rays.

A. R. PHILIP.

Mr. J. M. Brierley, of Rodwell, South Petherton, Somerset, reports:—

A brief display of the Aurora Borealis was observed here on August 11th, 1939. Beginning at 22h. 55m. G.M.T., as a faint glow in the shape of an arch from NW to NNW. At 23h. 10m. several faint streamers were observed to reach an elevation of 20°, the elevation of the arch being about 50°. At 23h. 15m. the streamers had vanished and the arch had assumed a very faint pinkish hue; by 23h. 30m. all trace of the arch had disappeared.

Auroral display on November 4th, 1322.

Matthew of Westminster gives the following account:—

“ on the fourth day of November at the first hour of the night in the western parts beyond the city of London near the village of Uxbridge, there appeared in the air to many beholders a wonderful sign. For a certain pile of fire of the size and shape of a small boat, pallid, but of a livid colour, rising up from the south and crossing the firmament with a slow and grave motion, set its course towards the north. Out of the front of this pile another very fervent fire of a red colour and of greater quantity, similar in shape to the former, burst forth immediately with bright beams and great speed, flying through the air, which were seen quickly meeting against each other by many beholders. And by turns frequently approaching with collisions and engaging in fearful combat, the blows of which conflict and the sounds of the crashes were heard at a distance from the beholders ”.

C. E. BRITTON.

Sunshine in 1911.

The largest annual total of sunshine on record is given on page 241 as 2,158 hours at Eastbourne in 1911. Capt. J. E. Cowper points out that in the same year

2,193 hours occurred at Shanklin, Isle of Wight, although this station did not report to the Meteorological Office for inclusion in the *Monthly Weather Report*.

Sunshine, October, 1939

The distribution of bright sunshine for the month was as follows:—

	Total hrs.	Diff. from average hrs.		Total hrs.	Diff. from average hrs.
Stornoway	134	+57	Chester	95	+ 4
Aberdeen	109	+15	Ross-on Wye	108	+ 9
Dublin .. ..	..	..	Falmouth	144	+31
Birr Castle	118	+28	Gorleston .. ..	..	..
Valentia	140	+50	Kew	90	- 6

Kew temp., mean, 47·7° F. diff. from average -3·9° F.

General Rainfall, October, 1939

	Per cent.
England and Wales	120
Scotland	79
Ireland	80
British Isles	101

OBITUARY

Vice-Admiral Sir H. Percy Douglas.

We regret to announce the death on November 4th, 1939, of Sir Percy Douglas. Sir Percy was in April 1917, appointed as the first Director of the Naval Meteorological Service. He held this post until January 1918, and in 1924 he was appointed Hydrographer of the Navy, holding this post until 1932. While Hydrographer he did much valuable work on Government and other Committees, including the Meteorological Committee and those dealing with s.s. *Discovery* and with pollution of the River Tees.

A. W. Shadick.

We regret to announce the death on October 25th, 1939, of Mr. A. W. Shadick. Mr. Shadick was responsible for the meteorological station maintained by the Clacton Urban District Council from 1901 until his death at the age of 81. Although since 1934 his failing health debarred him from taking any active part in the work of the station his interest was maintained, and he will be remembered by many as a keen observer and a genial character.

Rainfall : October 1939 : England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
<i>Lond'n</i>	Camden Square.....	6.10	232	<i>Warw</i>	Alcester, Ragley Hall.	4.25	155
<i>Surrey</i>	Reigate, Wray Pk. Rd.	6.71	202	"	Birmingham, Edgbaston	3.35	121
<i>Kent</i>	Tenterden, Ashenden	7.34	205	<i>Leics</i>	Thornton Reservoir...	4.37	156
"	Folkestone, I. Hospital	14.11	..	"	Belvoir Castle.....	3.09	114
"	Margate, Cliftonville..	10.28	351	<i>Rutl'd</i>	Ridlington	3.80	135
"	Edenb'dg., Falconhurst	7.90	219	<i>Lincs</i>	Boston, Skirbeck.....	3.48	127
<i>Sussex</i>	Compton, Compton Ho	6.32	138	"	Cranwell Aerodrome...	3.52	123
"	Patching Farm.....	6.79	189	"	Skegness, Marine Gdns	3.67	134
"	Eastbourne, Wil. Sq..	8.25	199	"	Louth, Westgate.....	4.23	131
<i>Hants.</i>	Ventnor, Roy. Nat. Hos.	8.72	222	"	Brigg, Wrawby St....	2.72	..
"	Southampton, East Pk	6.05	154	<i>Notts</i>	Mansfield, Carr Bank.	3.14	103
"	Ovington Rectory....	5.69	141	<i>Derby</i>	Derby, The Arboretum	3.29	121
"	Sherborne St. John...	4.75	135	"	Buxton, Terrace Slopes	3.88	79
<i>Herts.</i>	Royston, Therfield Rec	4.84	178	<i>Ches.</i>	Bidston Obsy.....	2.59	79
<i>Bucks.</i>	Slough, Upton.....	4.63	165	<i>Lancs.</i>	Manchester, Whit. Pk.	1.50	45
<i>Oxford</i>	Oxford, Radcliffe.....	5.27	182	"	Stonyhurst College...	1.47	33
<i>N'hant</i>	Wellingboro, Swanspool	4.49	178	"	Southport, Bedford Pk	1.95	55
"	Oundle	3.52	..	"	Ulverston, Poaka Beck	2.03	37
<i>Beds.</i>	Woburn, Exptl. Farm.	3.83	143	"	Morecambe.....	.97	25
<i>Cambs</i>	Cambridge, Bot. Gdns.	3.83	162	"	Blackpool	1.68	45
"	March	3.89	150	<i>Yorks.</i>	Wath-upon-Deane...	2.30	83
<i>Essex.</i>	Chelmsford, County Gns	..	..	"	Wakefield, Clarence Pk.	2.68	93
"	Lexden Hill House...	7.76	..	"	Oughtershaw Hall....	3.78	..
<i>Suff</i>	Haughley House.....	5.41	..	"	Harrog'te, Harlow Moor	2.92	85
"	Campsea Ashe, High Ho	8.77	336	"	Hull, Pearson Park...	3.67	123
"	Lowestoft Sec. School.	6.45	231	"	Holme-on-Spalding ..	2.77	92
"	Bury St. Ed., Westley H	5.59	206	"	Felixkirk, Mt. St. John	3.65	127
<i>Norfol.</i>	Wells, Holkham Hall..	4.49	160	"	York, Museum.....	2.24	83
<i>Wilts.</i>	Porton, W.D. Exp'l Stn	4.85	155	"	Scarborough.....	3.12	100
"	Bishops Cannings....	4.26	128	"	Middlesbrough	4.58	153
<i>Dorset</i>	Weymouth, Westham.	6.07	166	"	Baldersdale, Hury Res.	..	..
"	Beaminster, East St..	5.29	119	<i>Durhm</i>	Ushaw College	5.76	168
"	Shaftesbury	4.25	..	<i>Norl'd</i>	Newcastle, Leazes Pk.	4.79	155
<i>Devon.</i>	Plymouth, The Hoe....	5.26	133	"	Bellingham, Highgreen	4.92	126
"	Holne, Church Pk. Cott	7.51	114	"	Liburn Tower Gdns...	5.87	159
"	Teignmouth, Den Gdns	5.14	133	<i>Cumb.</i>	Carlisle, Scaleby Hall	1.98	59
"	Cullompton	4.23	102	"	Borrowdale, Seathwaite	4.75	42
"	Sidmouth, U.D.C.....	5.05	..	"	Thirlmere, Dale Head H.	5.45	61
"	Barnstaple, N. Dev. Ath	2.35	52	"	Keswick, High Hill...	3.20	57
"	Dartm'r, Cranmere P'l.	6.80	..	"	Ravenglass, The Grove	1.97	46
"	Okehampton, Uplands.	4.91	81	<i>West</i>	Appleby, Castle Bank.	2.06	59
<i>Cornw</i>	Redruth, Trewirgie...	..	..	<i>Mon.</i>	Abergavenny, Larchf'd	4.19	100
"	Bude, School House...	2.87	71	<i>Glam.</i>	Ystalyfera, Wern Ho.	4.06	59
"	Penzance, Morrab Gdns	3.08	66	"	Treherbert, Tynywaun	6.81	..
"	St. Austell, Trevarna..	4.94	94	"	Cardiff, Penylan.....	3.38	71
<i>Soms.</i>	Chewton Mendip.....	3.77	78	<i>Carm.</i>	Carmarthen, M. & P.Sc.	2.53	43
"	Long Ashton.....	2.93	78	<i>Card</i>	Aberystwyth	3.07	..
"	Street, Millfield.....	2.80	88	<i>Radn'r</i>	Bir. W. W. Tyrmynydd	3.76	57
<i>Glostr.</i>	Blockley	4.22	..	<i>Mont</i>	Lake Vyrnwy	3.90	69
"	Cirencester, Gwynfa..	3.63	110	<i>Flint</i>	Sealand Aerodrome...	3.36	115
<i>Here</i>	Ross-on-Wye	2.35	71	<i>Mer</i>	Blaenau Festiniog....	4.42	47
"	Kington, Lynhales...	2.61	70	"	Dolgelley, Bontddu...	2.62	43
<i>Salop.</i>	Church Stretton.....	3.65	..	<i>Carn.</i>	Llandudno	2.94	87
"	Shifnal, Hatton Grange	3.51	124	"	Snowdon, L. Llydaw 9	8.75	..
"	Cheswardine Hall....	4.02	129	<i>Angl</i>	Holyhead, Salt Island.	3.48	87
<i>Worc</i>	Malvern, Free Library	3.32	111	"	Lligwy.....	2.73	..
"	Ombersley, Holt Lock.	2.73	102	<i>I. Man</i>	Douglas, Boro' Cem...	3.21	71

Rainfall : October 1939 : Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
<i>Guern.</i>	St. Peter P't. Grange Rd.	6.63	147	<i>R & C.</i>	Stornoway, C.G. Stn.	3.28	6
<i>Wig.</i>	Pt. William, Monreith.	3.96	100	<i>Suth.</i>	Lairg	3.14	84
"	New Luce School	4.14	89	"	Skerray Borgie	2.35	..
<i>Kirk.</i>	Dalry, Glendaroch	3.40	65	"	Melvich	2.73	74
<i>Dumf.</i>	Eskdalemuir Obs.	3.32	61	"	Loch More, Achfary	3.03	39
<i>Roxb.</i>	Hawick, Wolfelee	3.50	91	<i>Caith.</i>	Wick	1.56	53
"	Kelso, Broomlands	2.84	98	<i>Orkney</i>	Deerness	..	..
<i>Peabs.</i>	Stobo Castle	3.44	100	<i>Shet.</i>	Lerwick Observatory	2.12	54
<i>Berw.</i>	Marchmont House	4.19	110	<i>Cork.</i>	Cork, University Coll.	4.53	116
<i>E. Lot.</i>	North Berwick Res.	2.82	95	"	Roches Point, C.G. Stn.	3.84	94
<i>Midl.</i>	Edinburgh, Blackfd. H	1.99	73	"	Mallow, Hazlewood	2.65	..
<i>Lanark.</i>	Auchtyfardle	1.49	..	<i>Kerry.</i>	Valentia Observatory	4.17	75
<i>Ayr.</i>	Kilmarnock, Kay Park	1.30	..	"	Gearhamen	8.40	91
"	Girvan, Pinmore	2.65	53	"	Bally McElligott Rec.	6.23	..
"	Glen Afton, Ayr San.	3.98	78	"	Darrynane Abbey	3.88	77
<i>Renf.</i>	Glasgow, Queen's Park	2.41	74	<i>Wat.</i>	Waterford, Gortmore	3.60	92
"	Greenock, Prospect H.	3.63	72	<i>Tip.</i>	Nenagh, Castle Lough	1.19	35
<i>Bute.</i>	Rothsay, Arden Craig	2.15	49	"	Cashel, Ballinamona	1.41	40
"	Dougarie Lodge	2.76	67	<i>Lim.</i>	Foynes, Coolnanes	2.95	78
<i>Argyll.</i>	Loch Sunart, G'dale	3.02	46	"	Limerick, Mulgrave St.	1.53	44
"	Ardgour House	2.15	..	<i>Clare.</i>	Inagh, Mount Callan	5.34	..
"	Glen Etive	..	..	<i>Wexf.</i>	Gorey, Courtown Ho.	3.15	89
"	Oban	1.61	..	<i>Wick.</i>	Rathnew, Clonmannon	3.98	..
"	Poltalloch	2.63	53	"	Blessington Rectory	..	..
"	Inveraray Castle	4.98	71	<i>Carlow</i>	Bagnalstown Fenagh H	2.86	85
"	Islay, Eallabus	1.92	40	"	Hacketstown Rectory	3.91	103
"	Mull, Benmore	3.70	29	<i>Leix.</i>	Blandsfort House	1.94	55
"	Tiree	..	..	<i>Offaly.</i>	Birr Castle	.87	30
<i>Kinr.</i>	Loch Leven Sluice	3.45	100	<i>Dublin</i>	Dublin, Phoenix Park	2.89	109
<i>Fife.</i>	Leuchars Aerodrome	3.51	135	<i>Meath.</i>	Kells, Headfort	3.04	91
<i>Perth.</i>	Loch Dhu	4.90	69	<i>W.M.</i>	Moate, Coolatore	1.50	..
"	Crieff, Strathearn Hyd.	3.24	82	"	Mullingar, Belvedere	1.97	63
"	Blair Castle Gardens	5.08	164	<i>Long.</i>	Castle Forbes Gdns.	2.62	80
<i>Angus.</i>	Kettins School	5.19	164	<i>Galway</i>	Galway, Grammar Sch.	2.98	80
"	Pearsie House	6.87	..	"	Ballynahinch Castle	4.53	76
"	Montrose, Sunnyside	3.02	109	"	Ahascragh, Clonbrock	2.91	80
<i>Aberd.</i>	Balmoral Castle Gdns.	6.38	177	<i>Rosc.</i>	Strokestown, C'node	3.12	102
"	Logie Coldstone Sch.	..	..	<i>Mayo.</i>	Blacksod Point	5.26	105
"	Aberdeen Observatory	3.09	103	"	Mallaranny	6.13	..
"	New Deer School House	4.37	115	"	Westport House	4.07	90
<i>Moray.</i>	Gordon Castle	4.08	129	"	Delphi Lodge	10.36	109
"	Grantown-on-Spey	..	..	<i>Sligo.</i>	Markree Castle	3.24	79
<i>Nairn.</i>	Nairn	2.50	106	<i>Cavan.</i>	Crossdoney, Kevit Cas.	3.00	..
<i>Inu's.</i>	Ben Alder Lodge	..	..	<i>Ferm.</i>	Crom Castle	2.78	86
"	Kingussie, The Birches	1.39	..	<i>Arm'h.</i>	Armagh Obsy	3.59	132
"	Loch Ness, Foyers	1.60	48	<i>Down.</i>	Fofanny Reservoir	8.91	..
"	Inverness, Culduthel R	2.03	83	"	Seaforde	3.33	94
"	Loch Quoich, Loan	4.63	..	"	Donaghadee, C. G. Stn.	3.08	107
"	Glenquoich	2.18	22	<i>Antrim</i>	Belfast, Queen's Univ.	2.38	72
"	Arisaig House	1.33	23	"	Aldergrove Aerodrome	2.01	67
"	Glenleven, Corroul	2.62	43	"	Ballymena, Harryville	2.54	69
"	Ft. William, Glasdrum	2.55	..	<i>Lon.</i>	Garvagh, Moneydig	2.23	..
"	Skye, Dunvegan	..	..	"	Londonderry, Creggan	2.21	60
"	Barra, Skallary	1.23	..	<i>Tyrone</i>	Omagh, Edenfel	2.22	60
<i>R & C.</i>	Tain, Ardlarach	1.73	57	<i>Don.</i>	Malin Head	2.14	56
"	Ullapool	1.81	37	"	Dunfanaghy	1.93	50
"	Achnashellach	2.45	31	"	Dunkineely	1.90	..

Climatological Table for the British Empire, April, 1939

STATIONS.	PRESSURE.		TEMPERATURE.							Relative Humidity.	Mean Cloud Am't	PRECIPITATION.			BRIGHT SUNSHINE.				
	Mean of Day M.S.L.	Diff. from Normal.	Absolute.			Mean Values.						Am't.	Diff. from Normal.	Days.	Hours per day.	Per-centage of possible.			
			Max.	Min.	°F.	Max.	Min.	1/2 and 2 Min.	Diff. from Normal.								Wet Bulb.		
																		°F.	°F.	°F.
London, Kew Obsy....	1014.0	—	0.4	72	32	55.8	41.4	48.6	+	1.5	42.9	85	5.4	2.21	+	0.76	16	5.8	42
Gibraltar.....	1016.1	—	0.3	72	48	62.5	52.4	57.5	—	3.4	51.1	77	4.6	2.99	—	—	8	9.5	72
Malta.....	1013.2	—	0.2	69	51	63.3	55.1	59.2	—	1.7	55.2	81	5.8	2.37	+	1.51	6	8.0	61
St. Helena.....	1016.4	—	0.2	73	59	68.0	61.4	64.7	+	0.4	62.9	93	8.9	4.59	+	1.37	26	—	—
Freetown, Sierra Leone	1011.8	+	2.7	90	73	87.5	74.4	80.9	—	—	71.9	83	7.4	1.59	—	2.47	4	—	—
Lagos, Nigeria.....	1009.9	+	0.5	90	69	87.3	74.7	81.0	—	1.8	75.6	88	7.2	3.76	—	2.32	10	7.0	57
Kaduna, Nigeria.....	1008.4	—	—	97	61	91.9	72.2	82.1	—	0.1	71.8	81	4.9	3.01	—	0.07	6	8.7	71
Zomba, Nyasaland....	1011.7	—	0.8	84	59	78.0	62.1	70.1	+	0.8	65.3	82	7.1	6.13	+	2.47	11	—	—
Salisbury, Rhodesia ..	1015.2	—	0.4	82	45	75.5	52.3	63.9	—	1.8	57.5	67	3.7	0.56	—	—	4	8.8	75
Cape Town.....	1017.0	+	0.6	87	47	72.1	53.7	62.9	—	0.3	56.4	88	6.0	1.47	—	0.40	12	—	—
Johannesburg.....	1015.5	+	0.6	77	28	70.0	49.4	59.7	—	0.3	49.8	55	2.0	0.28	—	1.46	4	8.3	72
Mauritius.....	1014.0	+	0.1	85	67	82.4	71.6	77.0	+	1.2	73.0	75	5.4	4.33	—	0.79	23	8.5	73
Calcutta, Alipore Obsy.	1005.8	—	0.5	107	67	100.2	78.1	89.1	+	3.5	77.9	77	3.2	1.57	—	0.61	1*	—	—
Bombay.....	1008.3	—	0.5	91	73	87.9	76.0	81.9	—	1.2	74.6	74	2.1	0.00	—	0.05	0*	—	—
Madras.....	1007.6	—	0.8	97	68	90.4	77.2	83.8	—	1.5	77.6	76	5.5	5.23	+	4.60	3*	—	—
Colombo, Ceylon.....	1008.9	+	0.2	89	73	87.2	76.1	81.7	—	1.0	77.5	78	7.3	10.67	+	0.94	24	6.8	55
Singapore.....	1008.8	—	0.1	91	73	86.9	76.0	81.5	—	0.1	77.8	77	6.4	8.73	+	1.10	16	5.8	48
Hongkong.....	1013.0	+	0.4	81	50	72.5	65.0	68.7	—	2.1	65.2	81	8.2	15.80	+	10.15	13	3.0	24
Sandakan.....	1009.1	—	—	90	74	87.4	77.0	82.2	—	0.0	77.8	83	7.7	6.43	+	1.94	11	—	—
Sydney, N.S.W.....	1018.9	+	0.5	77	51	72.3	59.8	66.1	+	1.4	61.1	79	6.0	3.93	—	1.59	15	4.5	40
Melbourne.....	1019.1	—	0.4	82	42	68.7	53.3	61.0	+	1.5	56.0	75	7.8	4.48	+	2.31	17	4.1	37
Adelaide.....	1019.3	—	0.5	90	49	74.7	56.0	65.3	+	1.4	58.1	60	7.0	2.15	+	0.43	14	6.3	57
Perth, W. Australia....	1018.7	+	0.3	89	41	77.1	56.5	66.8	—	0.0	58.7	59	3.4	1.08	—	0.57	4	8.4	75
Coolgardie.....	1016.1	—	2.2	91	40	77.1	54.9	66.0	+	1.0	58.0	69	2.9	1.44	+	0.48	5	—	—
Brisbane.....	1018.5	+	0.9	81	55	76.2	60.4	68.3	—	2.0	65.0	78	6.3	4.47	+	0.70	18	4.8	42
Hobart, Tasmania.....	1016.9	+	2.1	79	37	65.5	49.8	57.7	+	2.5	52.1	75	6.8	1.16	—	0.69	16	4.8	44
Wellington, N.Z.....	1023.1	+	5.0	71	42	61.4	51.3	56.3	—	0.8	53.6	79	7.0	2.95	—	0.93	10	5.1	46
Suva, Fiji.....	1010.8	+	0.2	88	69	83.1	72.6	77.9	—	0.7	74.1	87	7.7	16.98	+	4.77	24	4.0	34
Apia, Samoa.....	1010.2	+	0.3	87	72	84.8	74.4	79.6	+	0.7	76.0	81	—	9.00	—	1.15	18	6.9	59
Kingston, Jamaica.....	1014.7	+	0.6	87	65	85.0	68.6	76.8	—	1.6	68.1	78	3.1	1.81	+	0.57	6	5.2	42
Grenada, W.I.....	1010.5	—	2.0	89	71	86.0	72.0	79.0	+	0.1	75.0	83	5.0	6.57	+	4.41	14	—	—
Toronto.....	1013.4	—	2.7	75	24	46.7	34.4	40.5	—	1.6	34.6	78	7.6	3.43	+	1.14	13	4.5	34
Winnipeg.....	1016.3	—	0.4	83	3	44.3	25.6	36.9	—	0.8	26.0	77	5.4	1.08	+	0.32	7	7.7	56
St. John, N.B.....	1012.5	—	0.9	55	20	44.1	30.3	37.2	—	1.8	32.7	77	5.9	4.56	+	1.05	20	5.3	39
Victoria, B.C.....	1019.9	+	2.4	71	36	57.4	42.8	50.1	+	2.2	46.4	77	6.6	0.36	—	1.16	6	7.4	54

For Indian stations a rain day is a day on which 0.1 in. or more rain has fallen.

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